

TITLE:

5 **DIELECTRIC BARRIER DISCHARGE LAMP WITH PINCH SEAL**

TECHNICAL FIELD

The invention is based on a dielectric barrier
10 discharge lamp having at least one inner electrode, in particular with a tubular discharge vessel.

With this type of lamps, although the electrodes are arranged inside the discharge vessel, at least the
15 electrode of one polarity is separated from the interior of the discharge vessel by a dielectric, for example by a dielectric coating. In operation, this gives rise to what is known as a single-sided dielectric barrier discharge. Alternatively, it is also
20 possible for all the electrodes to be provided with a dielectric barrier. This is then a two-sided dielectric barrier discharge.

Dielectric barrier discharge lamps with inner
25 electrodes have the advantage that the thickness and the materials properties of the dielectric layer can be optimized in terms of the discharge properties and lamp efficiency. The dielectric layer is typically from approximately one hundred to a few hundred μm thick. In
30 the case of outer electrodes, on the other hand, the thickness of the dielectric layer - i.e. in this case the wall thickness of the discharge vessel - is typically approx. 1 mm or above, depending on the size and shape of the discharge vessel. In addition, the
35 materials properties of the discharge vessel material, which under certain circumstances may be less favorable in terms of the barrier properties, also play a role. Consequently, lamps with outer electrodes generally also require higher operating voltages than lamps with

inner electrodes and therefore also require ballasts which are designed for higher voltages and are consequently more expensive. Moreover, the voltage-carrying outer electrodes have to be covered with an electrical insulation for safety reasons. However, inner electrodes require gastight current leadthroughs. This requires additional production steps.

Lamps of the generic type are used in particular in office automation (OA) appliances, e.g. color copiers and scanners, for signal illumination, e.g. as brake lights and indicators in automobiles, for auxiliary lighting, e.g. internal illumination in automobiles, and for background illumination of displays, e.g. liquid crystal displays.

These technical application areas require both particularly short start-up phases and also light fluxes which are as far as possible temperature-independent. Consequently, these lamps do not usually contain any mercury. Rather, these lamps are typically filled with noble gas, preferably xenon, or noble-gas mixtures. While the lamp is operating, in particular excimers, for example Xe_2^* , which emit a molecular band radiation with a maximum at approx. 172 nm, are formed inside the discharge vessel. Depending on the particular application, this VUV radiation is converted into visible light by means of phosphors. These lamps are preferably operated using the particularly efficient pulsed operating mode described in US 5,604,410.

BACKGROUND ART

US-A 6,097,155 has disclosed a tubular barrier discharge lamp with at least one inner electrode in strip form. One end of the tubular discharge vessel of the lamp is closed off in a gastight manner by a

stopper which is fused to part of the inner wall of the discharge vessel by means of soldering glass. The strip-like inner electrode runs to the outside as a supply conductor, through the soldering glass. One
5 drawback is that an additional soldering glass layer, as a gastight joining means, is required between stopper and vessel wall. Moreover, it is necessary to maintain tight tolerances in order to minimize scrap caused by leaks at the stopper seal.

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US-A 2002/0163306 has disclosed a tubular barrier discharge lamp with inner electrodes in strip form. At the end of the electrode leadthroughs, the discharge tube is closed off in a gastight manner with the aid of
15 a disk-like closure element which does not use any connecting means. For this purpose, at this end the discharge tube is provided with a constriction which surrounds the edge of the disk-like closure element in the form of a ring. Then, the constriction and the
20 disk-like closure element are fused together in a gastight manner, with the inner electrodes leading out through this fused joint. A drawback of this arrangement is the relatively high production costs.

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DISCLOSURE OF THE INVENTION

The object of the invention is to avoid the above-mentioned drawbacks and to provide a dielectric barrier discharge lamp with a simplified closure technique.

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This object is achieved by a dielectric barrier discharge lamp having a discharge vessel which is filled with a discharge medium, at least one inner electrode which is arranged on the inner side of the
35 discharge vessel, a dielectric layer on at least one inner electrode, which layer separates the inner electrode or the inner electrodes from the discharge medium, at least one supply conductor, which is

electrically conductively connected to the at least one inner electrode in a leadthrough region, which leadthrough region is realized by a gastight pinch.

- 5 Particularly advantageous configurations are given in the dependent claims.

Advantages of this solution are the simple and therefore inexpensive production and the fact that the
10 supply conductors are fixedly and integrally connected to the lamp. This makes it possible to dispense with an additional production step for electrically connecting inner electrode and supply conductor, for example by means of soldering, which would otherwise be required.
15 Rather, sufficient and reliable electrical contact between inner electrode and supply conductor is produced by the pinch alone. To make it easier to bring the inner electrode and supply conductor into contact, it is advantageous for a widening of the otherwise thin
20 electrode track to be provided at that end of the inner electrode which is intended for contact, for example by a wide soldering dot being applied to said end.

Moreover, it is advantageous for the pinch to be
25 designed in such a manner that it completely surrounds the connection between the at least one inner electrode and the associated supply conductor. This effectively protects the connection from external environmental influences, such as oxidation, moisture, etc.

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In this context, it has been found that the pinch has no adverse effects on the dielectric barrier discharge even in the especially critical region adjoining the pinch. As far as it is currently possible to ascertain,
35 a crucial factor is that the dielectric layer should extend at least as far as the start of the pinch, and preferably partway into the pinch. Otherwise, there is a risk of an undesired high-current discharge structure

being formed in said boundary region, with the radiation or light being generated significantly less efficiently compared with the operating method disclosed in US-A 5,604,410. Moreover, it should be
5 ensured that the discharge vessel is deformed as little as possible in the boundary region by the pinch, and in particular that the electrode spacing should not be altered there. In the case of a tubular discharge vessel with two inner electrodes which are in strip
10 form and are oriented parallel to the longitudinal axis of the discharge vessel and arranged diametrically, this means that the pinch plane should deliberately be placed in the common plane of the two inner electrodes. As a result, the distance between the two inner
15 electrodes remains substantially unaffected by the pinch.

In a preferred embodiment, the at least one inner electrode is realized as a conductor track arranged on
20 the inner side of the wall of the discharge vessel. The at least one supply conductor is preferably realized by an electrically conductive wire, for example made from an iron-nickel alloy. In this context, it has proven advantageous for the wire diameter to be in the range
25 between 0.3 mm and 1.5 mm, preferably in the range between 0.5 mm and 1.0 mm. With wires of larger diameters, there is an increased risk of leaks, and with wires with a smaller diameter the mechanical robustness decreases and therefore so does the
30 practical viability of such wires.

Moreover, for production of the lamp it may be advantageous for an exhaust tube additionally to be provided inside the pinch region. In this case, a
35 suitable tool is used to pinch the discharge vessel in the region of the exhaust tube, in such a manner that the exhaust tube is then embedded in a gastight manner in the pinch but the discharge vessel can still be

evacuated, purged if necessary and finally filled with the discharge medium via the exhaust tube. Then, the exhaust tube is melted shut and the lamp is capped if required. In any event, it is possible for the free
5 ends of the supply conductors to make contact with any desired electrical power supply during assembly, for example by soldering, welding or clamping.

BRIEF DESCRIPTION OF THE DRAWINGS

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The invention is to be explained in more detail below with reference to an exemplary embodiment. In the drawing:

15 Fig. 1 shows a partial view of a discharge tube which is closed on one side,

Fig. 2a shows a longitudinal section through the unclosed end of the discharge tube shown in
20 Fig. 1 with an inserted exhaust tube and fitted supply conductors,

Fig. 2b shows a cross section through the discharge tube shown in Fig. 2a on line AA,
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Fig. 2c shows a zoomed-in illustration of an inner electrode with a dielectric barrier of the discharge tube shown in Fig. 1,

30 Fig. 3 shows a longitudinal section through that end of the discharge tube shown in Fig. 1 which has been closed off by means of a pinch,

Fig. 4a shows a side view of the finished barrier
35 discharge lamp,

Fig. 4b shows an end view of the finished barrier discharge lamp.

BEST MODE FOR CARRYING OUT THE INVENTION

The production and technical features of the dielectric
5 barrier discharge lamp according to the invention are
illustrated in the figures described below.

Figure 1 shows part of a discharge tube 1 with an
external diameter of approx. 10 mm made from soda-lime
10 glass (e.g. glass No. 360 produced by Philips and/or
AR-Glass produced by Schott), which is initially still
open at a first end 2 but has already been closed at
the other end 3 by means of a fused butt joint 4.

15 Figures 2a, 2b show the still open end 2 of the
discharge tube 1 in the form of a diagrammatic partial
longitudinal sectional view and a cross-sectional view
on line AA respectively. The inner wall of the
discharge vessel 1 has already been provided with two
20 diametrically arranged inner electrodes 5a, 5b which
are formed as linear conductor tracks and are made from
silver with a thickness of approx. 10 μm and a width of
approx. 1 mm, covered with a dielectric barrier 6a, 6b
made from soldering glass, thickness approx. 200 μm ,
25 width approx. 3.5 mm. Fig. 2c shows one of the inner
electrodes 5a including dielectric barrier 6a in the
form of a zoomed-in illustration. An exhaust tube 7 is
arranged centrally, and initially still loosely, in the
open end 2 of the discharge tube 1. Moreover, two
30 supply conductors 8a, 8b made from iron-nickel wire
with a thickness of 0.8 mm project into the still open
end 2 in such a manner that they each bear against an
associated inner electrode 5a, 5b and overlap the
latter by approx. $l = 5$ mm. To make it easier to bring
35 inner electrode 5a, 5b and associated supply conductor
8a, 8b into contact with one another, the end of the
inner electrode is widened with the aid of a square

soldering dot applied there in a size of approx. 4 mm by 4 mm.

Figure 3 is similar to Figure 2a. Here, however, the
5 previously open end 2 of the discharge tube 1 has now
been closed off by a pinch 9. The pinch 9 lies in the
longitudinal section plane which includes the two inner
electrodes 5a, 5b and consequently also the supply
conductors 8a, 8b which have been fitted to them (cf.
10 also Fig. 4a, 4b). This deliberate orientation of the
pinch plane means that the distance between the two
inner electrodes 5a, 5b remains virtually constant all
the way to the start of the pinch 9. In the direction
of the lamp longitudinal axis, the pinch 9 extends over
15 a length of approx. $L = 10$ mm and in so doing covers
both the overlap between the inner electrodes 5a, 5b
and the supply conductors 8a, 8b and also part of the
length d of the dielectric barriers 6a, 6b. In this
way, a reliable and mechanically robust contact between
20 the inner electrodes 5a, 5b and the supply conductors
8a, 8b is produced by means of the pinch 9, and this
contact is also protected from external environmental
influences. For this purpose, holding tongs or a U clip
is used before and during the pinching operation to
25 ensure that the supply conductors 8a, 8b bear against
the inner electrodes 5a, 5b with a gentle pressure. The
exhaust tube 7 is arranged in such a way that it
projects through the region of the pinch 9 partway into
the interior of the discharge tube 1. In this context,
30 the crucial factor is for the exhaust tube 7 still
initially to remain fully open after the pinching
operation. This ensures that the pinched lamp can still
be evacuated, if necessary purged one or more times and
finally filled with xenon as discharge medium to an end
35 pressure of approx. 15 kPa via the exhaust tube 7. Only
then is the exhaust tube 7 fused shut at its free end.

Figures 4a, 4b show the finished barrier discharge lamp with the exhaust tube 7 fused shut in the form of highly diagrammatic side and end views, respectively.

- 5 Depending on the particular application area, for example for use as an aperture lamp in OA appliances, it is optionally possible for the wall of the discharge vessel to be at least partially provided with phosphor.